14-2-213

Physics
Electricity and Magnetism

Fundamental quantities: These are the basic quantities in physics

quantity	S.I	C.g.s
Length	m	cm
Mass	kg	g
Time	s	s
Charge	C	C
Temperature	K	°C

Derived quantities: These are quantities derived from the fundamental ones.

1- Speed $= \frac{\text{distance}}{\text{time}} = m/s$

2- acceleration $= \frac{\text{distance}}{\text{time}^2} = m/s^2$

3- Force = mass x acceleration $= kg \times m/s^2 = \cancel{kgm^2/s^2}\ kg\,m/s^2 = N$

4- Current $= \frac{\text{charge}}{\text{time}} = C/s$

* There are 3 systems of units
  1- Standard International units (SI)
  2- Scientific units (c.g.s)
  3- Technical units

$10^{-3} \rightarrow$ milli (m)

$10^{-6} \rightarrow$ micro (μ)

$10^{-9} \rightarrow$ nano (n)

$10^{-10} \rightarrow$ Angstrom (Å)

$10^{-12} \rightarrow$ pico (p)

$10^{-15} \rightarrow$ femto (f)

Dimensions

Length → L

Mass → M

Time → T

charge → Q

Temp → Θ

Speed $= \frac{\text{distance}}{\text{time}} = \frac{L}{T} = LT^{-1}$

acceleration $= \frac{\text{distance}}{\text{time}^2} = \frac{L}{T^2} = LT^{-2}$

Force = mass × acceleration $= MLT^{-2}$

Current $= \frac{\text{charge}}{\text{time}} = QT^{-1}$

Applications of dimensions

1- To check whether the equation is correct or not

eg. $E=mc^2$

Dimensions of left side $= ML^2T^{-2}$

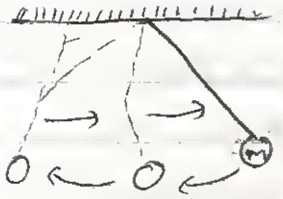
Dimensions of right side $= ML^2T^{-2}$ ⇒ correct equation

eg. $PV=nRT$

Dimensions of left side $= \frac{MLT^{-2}}{L^2} \cdot L^3 = ML^2T^{-2}$

Dimensions of right side $= \frac{ML^2T^{-2}}{\Theta} \cdot \Theta = ML^2T^{-2}$ ⇒ correct equation

2- To get the form of unknown equation



$T \propto l^x m^y g^z$

$T = k\, l^x m^y g^z$

Dimensions of left side: M^0L^0T

Dimensions of right side: $\cancel{LMLT} = \cancel{ML^2T^{-2}}$ $L^xM^y(LT^{-2})^z$

$y=0, \quad z=-\frac{1}{2} \quad x=\frac{1}{2}$

$T = k\sqrt{\frac{L}{g}}$

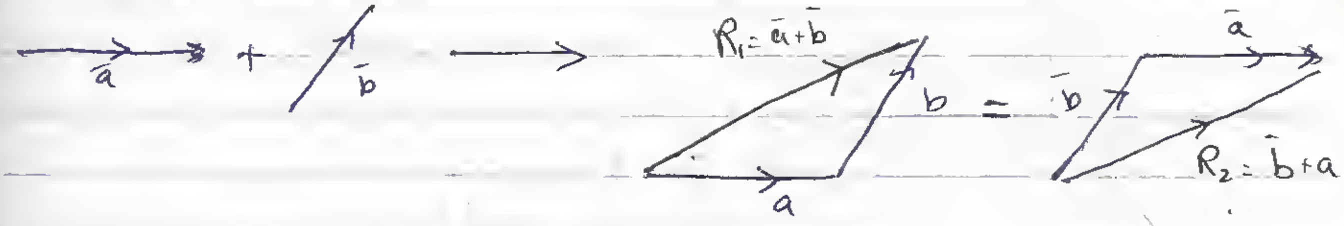
21-2-2013

Vectors

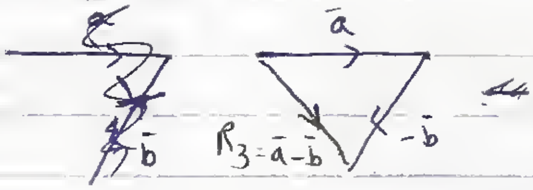
Addition and subtraction of vectors

① Graphically

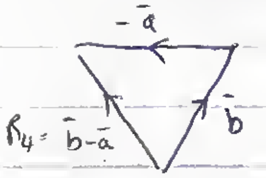
a) head-to-tail



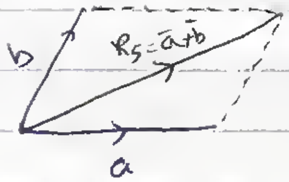
$\bar{a} - \bar{b} = \bar{a} + (-\bar{b})$



$\bar{b} - \bar{a} = \bar{b} + (-\bar{a})$

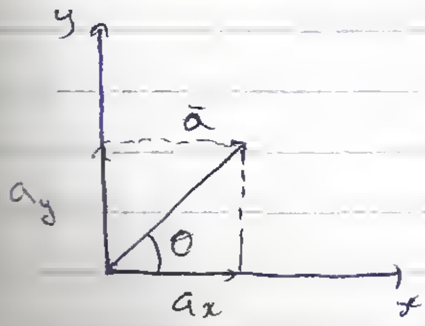


b) parallelogram



② numerically

components



a_x : x component of $\bar{a}$ $= a\cos\theta$

a_y : y component of $\bar{a}$ $= a\sin\theta$

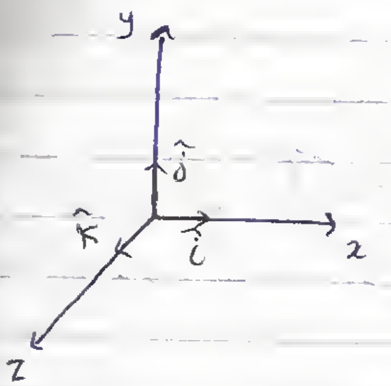
$$a = \sqrt{a_x^2 + a_y^2}$$

$$\theta = \tan^{-1}\left(\frac{a_y}{a_x}\right)$$

ector: It's a vector in certain direction and has magnit

unit vector : $\hat{a}$ vector : $\bar{a}$

$$\hat{a} = \frac{\bar{a}}{|\bar{a}|} \qquad \boxed{\bar{a} = \hat{a}\,|\bar{a}|}$$



$$\bar{a} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k}$$

$$\bar{a} = 3\hat{i} - \hat{j} + 2\hat{k}$$
$$\bar{b} = 5\hat{i} + 2\hat{j} - 6\hat{k}$$
$$\bar{a}+\bar{b} = 8\hat{i} + \hat{j} - \cancel{8}4\hat{k}$$
$$\bar{a}-\bar{b} = -2\hat{i} - 3\hat{j} + 8\hat{k}$$

Scalar (dot) product

$$\bar{a}\cdot\bar{b} = |\bar{a}|\cdot|\bar{b}|\cos\theta$$

$\hat{i}\cdot\hat{i} = \hat{j}\cdot\hat{j} = \hat{k}\cdot\hat{k} = 1$ (on same line, $\theta = 0$, $\cos\theta = 1$)

$\hat{i}\cdot\hat{j} = \hat{j}\cdot\hat{k} = \hat{k}\cdot\hat{i} = 0$ (perpendicular, $\theta = 90$, $\cos 90 = 0$)

$$\bar{a} = 3\hat{i} - \hat{j} + 2\hat{k}$$
$$\bar{b} = 5\hat{i} + 2\hat{j} - 6\hat{k}$$
$$\bar{a}\cdot\bar{b} = 15 - 2 - 12 = 1$$

$$\cos\theta = \frac{\bar{a}\cdot\bar{b}}{|\bar{a}|\cdot|\bar{b}|} = \frac{1}{\sqrt{9+1+4} \times \sqrt{25+4+36}}$$

$$\theta = \cancel{1.54}\ 88.1^\circ$$

Vector (cross) product

$\bar{a} \times \bar{b} = \bar{c}$

$|\bar{a} \times \bar{b}| = |\bar{c}| = |\bar{a}||\bar{b}| \sin\theta$

$\hat{i} \times \hat{i} = \hat{j} \times \hat{j} = \hat{k} \times \hat{k} = 0$ (same line, $\theta = 0$, $\sin 0 = 0$).

$\bar{a} = 3\hat{i} - \hat{j}$

$\bar{b} = 2\hat{i} + 5\hat{j}$

$\bar{a} \times \bar{b} = 15\hat{k} + 2\hat{k} = 17\hat{k}$

if vector is in 3D use determinant

$$\bar{a} \times \bar{b} = \begin{vmatrix} i & j & k \\ a_x & a_y & a_z \\ b_x & b_y & b_z \end{vmatrix}$$